PATENT ABSTRACTS OF JAPAN

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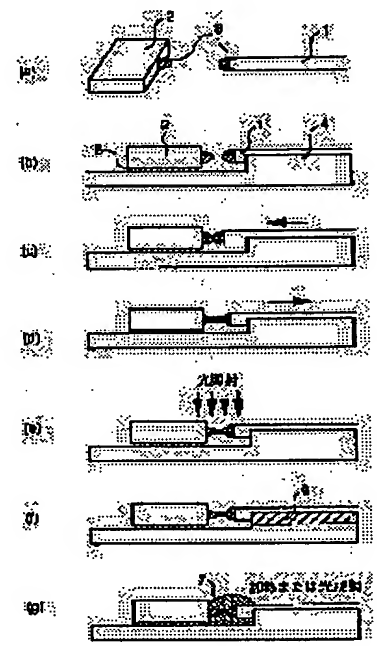
(54) METHOD FOR JOINING OPTICAL COMPONENT

(57)Abstract:

PROBLEM TO BE SOLVED: To simply adjust an optical axis with high precision and to prevent the occurrence of optical axis shift with the lapse of time by forming transparent resin for light guiding between optical component in a shape which is close to the diameter of an optical fiber or light receiving and emitting element.

SOLUTION: A liquid photosetting transparent resin 3 in unset state is dripped on the opening part end surfaces of a quartz optical fiber 1 and the light receiving and emitting element 2 to form hemispherical beads of the transparent resin. The light receiving and emitting element 2 is mounted on a silicon substrate 4 by using an adhesive 5. The quartz optical fiber 1 is mounted in a V groove which is formed in the silicon substrate 4 by chemical etching. This quartz optical fiber 1 after being moved toward the light receiving and emitting element and pressed through the transparency resin is put back to its original position to spread the transparency resin 3. The spread unset transparent resin 3 is set by being irradiated with ultraviolet rays, etc., to form a transparent light guide between the light receiving and emission part and quartz optical fiber 1.



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CLAIMS

[Claim(s)]
[Claim 1] The process which makes the transparence resin constituent in the condition of not hardening adhere to either [at least] the end face of an optical fiber, or opening of a **** light emitting device, The process arranged so that outline coincidence of the optical axis of said optical fiber and **** light emitting device may be carried out, The process which sticks said optical fiber and **** light emitting device by pressure through the transparence resin constituent in said condition of not hardening, The junction approach of the optical components characterized by including the process which pulls back said optical fiber and **** light emitting device, and extends the transparence resin constituent in said condition of not hardening, and the process which stiffens the this extended transparence resin constituent.
[Claim 2] The junction approach of the optical components characterized by said transparence resin constituent being a photo-setting resin constituent in the junction approach of an optical component according to claim 1.
[Claim 3] The junction approach of the optical components characterized by said transparence resin constituent being a thermosetting resin constituent in the junction approach of an optical component according to claim 1.
[Claim 4] The junction approach of the optical components characterized by said transparence resin constituent being a thermoplastics constituent in the junction approach of an optical component according to claim 1.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the optical components junction approach which is highly precise and moreover makes connection between optical components simple in an optical transceiver module.
[0002]

[Description of the Prior Art] Optic fiber communication is in the motion which application expands quickly to a subscriber system from a trunk system, and, as for the optical transceiver module used there, small, a thin shape, and low cost-ization are called for. It is dramatically difficult to perform optical-axis adjustment with an optical fiber and a **** light emitting device with high degree of accuracy in an optical module, since the core diameter of an optical fiber is very as thin as several micrometers. Light is performed on optical components, it tunes finely to a horizontal and a perpendicular direction by handicraft with through, and the actual condition is mainly looking for the location where the maximum effectiveness of optical connection is acquired. Therefore, a manufacturing cost will become very high and it is necessary to perform optical-axis adjustment between optical components in a simple list by low cost.

[0003] There is a method of mounting a light corpuscle child in a position by the reflow by the golden-tin solder bump currently indicated by JP,7-58149,A as an approach of performing optical-axis adjustment between optical components simply, using the surface tension of gold and tin solder. Moreover, after making the resin of a photoresist JP,60-173508,A intervene among optical components, such as an optical fiber and optical waveguide, the method of considering as the waveguide for association and making connection between optical components by package is indicated by hardening resin with the light which passed the optical fiber, and raising a refractive index.

[0004]

[Problem(s) to be Solved by the Invention] Said conventional technique has a problem in respect of versatility, although simplified compared with manual optical-axis adjustment. With a golden-tin solder bump connection method, in order to prevent the variation in location precision in optical-axis doubling, it is necessary to arrange the diameter of a solder bump with homogeneity in the precision of less than about 1 micrometer. Moreover, alignment of the optical components, such as an optical fiber, must be beforehand carried out in a high precision before mounting by the solder bump, and it must fix. It is accompanied by installation of a fixture for that or a substrate and the complicated activity for alignment. By the approach by the resin of a photoresist, a **** exposure part turns into a part for the non-hard spot of resin, and liquefied or in order to remain in the state of a half-solid, it is inferior to handling nature. Moreover, since a polymerization advances with time [a **** exposure part] while in use, change of an optical property, like the refractive-index difference of an optical waveguide part and other parts becomes small is seen. Furthermore, hardening contraction of resin causes the problem of an optical-axis gap with time. It is in offering the optical components junction approach of excelling in the dependability which does not cause the problem of an optical-axis gap with time while in use while the object of this invention is highly precise, and it moreover simplifies and it performs optical-axis adjustment between optical components in an optical transceiver module.

[0005]

[Means for Solving the Problem] The process at which the junction approach of the optical components of this invention makes the transparence resin constituent in the condition of not hardening adhere to either [at least] the end face of an optical fiber, or opening of a **** light emitting device, The process arranged so that outline coincidence of the optical axis of said optical fiber and **** light emitting device may be carried out, The process which pulls back the process which sticks said optical fiber and **** light emitting device by pressure through the transparence resin constituent in said condition of not hardening, and said optical fiber and **** light emitting device, and extends the transparence resin constituent in said condition of not hardening, and the process which stiffens the this extended transparence resin constituent are included.

[0006] Said transparence resin constituent is a photo-setting resin constituent, and this invention is the junction approach of optical components of stiffening this resin constituent by the exposure of light.

[0007] Said transparence resin constituent is a thermosetting resin constituent, and this invention is the junction approach of optical components of stiffening this resin constituent with heating.

[0008] Said transparence resin constituent is a thermoplastics constituent, and this invention is the

junction-approach of the optical components which made this thermoplastics constituent the condition of not hardening, by dissolving in heating or a solvent.

[0009] In the junction approach of the optical components of this invention, even when the transparence resin constituent in the condition of not hardening adhering to either [at least] the end face of an optical fiber or opening of a **** light emitting device is liquid drop-like also at the shape of a film, it is good.

[0010] In the optical components junction approach of this invention, it is highly precise, and because it is not necessary to set the location precision at the time of optical components immobilization as less than 1 micrometer, it can carry out by moreover simplify the optical-axis adjustment between optical components by form the transparence resin or the film for light guides among optical components in the configuration near the diameter of an optical fiber, or the path of a **** light emitting device. If outline immobilization of the optical components is carried out in the precision of about several micrometers, optical-axis doubling between optical components can be performed using the transparence resin or the film for light guides. Since the transparence resin or the film for light guides in this invention consists of homogeneous presentations which consist of a perfect polymer after junction on optical components, its optical property is uniform, and is [no aging in use] and is stable.

[0011]

[Embodiment of the Invention] This invention is explained with reference to a drawing.

[0012] (Example 1) Drawing 1 is drawing showing the optical components junction approach by this example. The condition of not hardening is liquefied to each opening end face of silica optical fiber 1 and the **** light emitting device 2, the transparence resin 3 of a photoresist is dropped at it, and the ball of the transparence resin 3 of a semicircle configuration is formed in it (drawing 1 (a)). Un-hardening is liquefied and the resin constituent which added the benzyl dimethyl ketal 3 weight section as a photopolymerization initiator to the constituent 100 weight section of tetraethylene glycol diacrylate and ethyl acrylate as transparence resin 3 of a photoresist is used. Next, the **** light emitting device 2 is carried in a silicon substrate 4 using adhesives 5. After silica optical fiber 1 prepares a V groove in a silicon substrate 4 by chemical etching, it is carried in V Mizogami (drawing 1 (b)). At this time, the **** light emitting device 2 and silica optical fiber 1 are arranged so that the amount of imperfect alignments of a **** light-emitting part and an optical fiber medial axis may carry out outline coincidence by about several micrometers, respectively. Moreover, distance of a carrier light-emitting part and a silica-optical-fiber edge is made into about 10mm of maximums. If it exceeds 10mm, the fracture of resin occurs and is not desirable at the time of sticking by pressure of the transparence resin 3 of the following liquefied photoresist, and an enlargement process. As the minimum distance, silica optical fiber 1 and said resin ball formed in each end face of the **** light emitting device 2 should just be extent which does not contact each other. After moving this silica optical fiber 1 to the direction of a **** light emitting device and being stuck by pressure through said transparence resin, it returns to the origin of silica optical fiber to a location, and transparence resin 3 is extended (drawing 1 (c), (d)). Said transparence resin 3 in the extended condition of not hardening is hardened by the optical exposure of ultraviolet rays etc., and forms transparent optical waveguide a **** light-emitting part, silica optical fiber 1, and in between (drawing 1 (e)). Here, if it is made to carry out, extending said transparence resin 3 in the condition of not hardening, since the sag by the self-weight of resin will be prevented and straight-line-like optical waveguide will be obtained mostly, the optical exposure of ultraviolet rays etc. is especially suitable. Silica optical fiber 1 is fixed to V Mizogami of a silicon substrate 4 using the adhesives 6 of a photoresist (drawing 1 (f)). After immobilization in V Mizogami of the silicon substrate 4 of silica optical fiber makes the adhesives 6 of a photoresist V Mizogami with ** at the time of the process of drawing 1 (b), it can carry silica optical fiber 1 and the optical exposure at the time of the drawing 1 (e) process can also perform it by package. If required, as shown in drawing 1 (g), transparent optical waveguide can be stiffened with light or heat using the transparence resin 7 of a refractive index lower than this optical waveguide, and it can fix. At this time, the transparence resin 7 of a low

refractive index also carries out mechanical reinforcing materials's duty only as a clad plate of an optical waveguide part.

[0013] (Example 2) The resin ball of the semicircle configuration by thermoplastic transparence resin 3 is formed in each opening end face of silica optical fiber 1 and the **** light emitting device 2 like an example 1. A nonvolatile matter 80wt% tetrahydro furan solution is dropped at each end face of silica optical fiber 1 and the **** light emitting device 2, using the copolymer of polymethylmethacrylate and butyl acrylate as thermoplastics. After leaving it at a room temperature for 4 hours and vaporizing almost all solvents, 80 degrees C is heated for 30 minutes, and the resin ball shown in drawing 1 (a) is formed. As shown in drawing 1 (b), after carrying silica optical fiber 1 and the **** light emitting device 2 in a silicon substrate 4, it is stuck by pressure, performing partial heating of infrared heating etc. at about 150 degrees C, and, subsequently enlargement of transparence resin is performed (drawing 1 (c), (d)). As shown in drawing 1 (f), silica optical fiber 1 is fixed to V Mizogami of a silicon substrate 4 using the adhesives 6 of a photoresist. If required, the formed optical waveguide can be stiffened with light or heat like drawing 1 (g) using the transparence resin 7 of a refractive index lower than it, and it can fix. It is more desirable to use the resin of a photoresist as an object for adhesion immobilization, since thermoplastics is used as optical waveguide transparent in this example.

[0014] (Example 3) In this example, how to form the ball of the transparence resin 3 of a semicircle configuration in **** light-emitting part 9 end face of the **** light emitting device 2 is shown in drawing 2 . As shown in drawing 2 (a), after making photoresist material with ** the opening end face of the **** light-emitting part 9 and irradiating ultraviolet rays through a photo mask at photoresist material, the dam 8 for carrying out etching clearance of the photoresist material of an unexposed part with a solvent, and forming the ball of liquefied transparence resin 3 is formed. Next, liquefied heat or a liquefied photo-setting resin is dropped in the dam 8 of **** light-emitting part 9 end face using a dispenser 10, and the ball of the transparence resin 3 of a semicircle configuration is formed (drawing 2 (b)). At this time, the thermoplastics dissolved in the solvent instead of liquefied heat or a photo-setting resin can also be used.

[0015] (Example 4) Drawing 3 is drawing showing how to form the transparence resin ball of a semicircle configuration in the carrier light-emitting part end face of a **** light emitting device in this example. As shown in drawing 3 (a), the end face of the **** light-emitting part 9 of the **** light emitting device 2 is etched into a concave by fluoric acid (HF). At this time, solder resist is used as a mask for etching. Then, a dispenser is used for the crevice of the end face of this **** light-emitting part 9, liquefied heat or a liquefied photo-setting resin is dropped at it, and the ball of the transparence resin 3 of a semicircle configuration is formed in it. In addition, the thermoplastics dissolved in the solvent like the example 3 may be dropped.

[0016] (Example 5) In this example, how to form a bright film in the end face of the **** light-emitting part 9 of the **** light emitting device 2 is shown in drawing 4 . As shown in drawing 4 (a), after laminating the photoresist film 11 of a transparent positive type in the end face of the **** light emitting device 2, ultraviolet rays are irradiated at the photoresist film 11 through the glass photo mask which carried out the chrome plating of except for opening of the **** light-emitting part 9. Next, etching clearance of the unexposed part of a resist film is carried out with a solvent, and a bright film is formed in opening of the end face of the **** light-emitting part 9 of the **** light emitting device 2 (drawing 4 (b)). It is also possible to use a negative-mold photoresist instead of the positive type photoresist of this example, and to form a bright film in the end face of the **** light-emitting part 9 of the **** light emitting device 2.

[0017] (Example 6) How to form the transparence resin ball of a semicircle configuration in the end face of silica optical fiber 1 of this example is shown in drawing 5 . As shown in (a) of drawing 5 , a dispenser 10 is used for the end face of silica optical fiber 1, and liquefied heat or the transparence potting resin 14 of a photoresist is dropped. The ball of the transparence resin 3 of a semicircle configuration forms the dropped liquefied transparence resin with surface tension. (Drawing 5 (b)) . In this example, the

thermoplastics dissolved in the solvent instead of liquefied heat or a photo-setting resin can also be .used.

[0018] (Example 7) How to form the ball of the transparence resin 3 of a semicircle configuration in the end face of silica optical fiber 1 of this example is shown in drawing 6 . As shown in drawing 6 (a), the end face of silica optical fiber 1 is contacted to the liquefied transparence resin 15 hardened with heat or light. It is made not to put the end face of silica optical fiber 1 into liquefied transparence resin 15 in inside at this time. Next, by pulling up said optical fiber, the ball of the liquefied transparence resin 3 of a semicircle configuration is formed in the end face of silica optical fiber 1 (drawing 6 (b)). Here, the thermoplastics dissolved in the solvent like the example 6 can be used.

[0019] (Example 8) How to form the ball of the transparence resin 3 of a semicircle configuration in the end face of an optical fiber of this example is shown in drawing 7 . As shown in drawing 7 (a), the end face of the optical waveguide section 16 of silica optical fiber 1 is etched into a concave using fluoric acid (HF). Rinsing and after carrying out stoving, a dispenser is used for the crevice of this optical fiber end face for an optical fiber end face, liquefied heat or a liquefied photo-setting resin is dropped, and the ball of the transparence resin 3 of a semicircle configuration is formed (drawing 7 (b)). Here, the thermoplastics dissolved in the solvent like the example 6 can be used.

[0020] (Example 9) The optical components junction approach by this example is shown in drawing 8 . Plastics optical waveguide with a die length of 1mm is pasted up on the end face of silica optical fiber 1 (drawing 8 (a)). Hot-rolling growth is carried out and plastics optical waveguide produces the optical fiber with which the high refractive-index core section 17 consists of polymethylmethacrylate, and the low refractive-index clad section 18 consists of fluorination polymethylmethacrylate until it becomes the outer diameter of 10-20 micrometers. After making the silicone resin, acrylic resin, or polyurethane resin adhesives of a photoresist into one of each end faces, or both for said plastics optical waveguide and silica optical fiber 1 with **, it pastes up by carrying out UV irradiation, with each end face compared. After injecting into the comparison part of plastics optical waveguide and silica optical fiber the solvent which dissolves plastics optical waveguide, for example, a methylene chloride etc., at this time, both can also be pasted up by drying.

[0021] Next, the liquefied photoresist transparence resin in the condition of not hardening is dropped at the opening end face of the **** light emitting device 2, and the ball of the transparence resin 3 of a semicircle configuration is formed (drawing 8 (b)). It is 2-hydroxy-2-methyl as a photopolymerization initiator to the urethane acrylate resin constituent 100 weight section to which the urethane resin which consists of isocyanate and a polyether glycol, and hydroxyl ethyl acrylate were made to react as non-hardened liquefied photoresist transparence resin. - The resin constituent which added the 1-phenyl-propane-1-ON 3 weight section is used. Then, the **** light emitting device 2 is carried in a silicon substrate 4 using adhesives 5. After silica optical fiber 1 prepares a V groove in a silicon substrate 4 by chemical etching beforehand, it is carried in V Mizogami (drawing 8 (c)). At this time, the **** light emitting device 2 and silica optical fiber 1 are arranged so that the amount of imperfect alignments of a **** light-emitting part and an optical fiber medial axis may carry out outline coincidence by about several micrometers, respectively. Moreover, the distance of a **** light-emitting part and silica optical fiber is 0.5mm. It considers as extent. After moving this silica optical fiber to the direction of a carrier light emitting device and being stuck by pressure through transparence resin 3, silica optical fiber is returned to the original location, and transparence resin 3 is extended (drawing 8 (d), (e)). The liquefied photoresist transparence resin in the extended condition of not hardening is stiffened by the exposure of light, such as ultraviolet rays, and the plastics optical waveguide linked to a **** light-emitting part and silica optical fiber is pasted up. (Drawing 8 (f)) . Silica optical fiber is fixed to V Mizogami of a silicon substrate using the adhesives of a photoresist (drawing 8 (g)). After immobilization in silicon substrate V Mizogami of silica optical fiber makes the adhesives 6 of a photoresist V Mizogami with ** at the time of the process of drawing 8 (c), it can carry silica optical fiber and the optical exposure at the time of the process of drawing 8 (f) can also perform it by package. If required, as shown in drawing 8 (h), from

said transparence resin 3, using the transparence resin 7 of a low refractive index, it can be made to be able to harden with light or heat, and can fix. At this time, the transparence resin 7 of a low refractive index is not only used as a clad plate of an optical waveguide part, but carries out the duty of mechanical reinforcement.
[0022] (Example 10) The junction approach of the optical components by this example is shown in drawing 10. This example is the approach of carrying a ferrule in V Mizogami of a silicon substrate 4, and performing junction of an optical fiber and a **** light emitting device, after inserting silica optical fiber 1 in a metal or the glass ferrule 20. After inserting in the ferrule 20 made from a zirconia the silica optical fiber 1 cut in die length of 30mm and fixing using the adhesives of a photoresist, the thermosetting liquefied transparence resin 3 in the condition of not hardening is dropped at each opening end face of this optical fiber and the **** light emitting device 2, and the resin ball of a semicircle configuration is formed (drawing 9 (a)). As non-hardened liquefied thermosetting transparence resin, the transparence silicon resin of 2 acidity or alkalinity which can be hardened at a room temperature is used. Next, the **** light emitting device 2 is carried in a silicon substrate 4 using adhesives 5. After silica optical fiber 1 prepares a V groove in a silicon substrate 4 by chemical etching, it is carried in V Mizogami (drawing 9 (b)). At this time, the **** light emitting device 2 and silica optical fiber 1 are arranged so that the amount of imperfect alignments of a **** light-emitting part and an optical fiber medial axis may carry out outline coincidence by about several micrometers, respectively. Moreover, distance of a **** light-emitting part and silica optical fiber is set to about 2mm. After moving the ferrule 20 which inserted this silica optical fiber 1 to the direction of a carrier light emitting device and being stuck by pressure through transparence resin 3, it returns to a location based on a ferrule, and transparence resin 3 is extended (drawing 1 (c), (d)). After leaving the liquefied thermosetting transparence resin in the extended condition of not hardening, at a room temperature for 20 hours, it heat-hardens on 60-degree-C conditions of 1 hour, and it forms optical waveguide between a **** light-emitting part and silica optical fiber 1 (drawing 9 (e)). Here, after leaving said silicone transparence resin in the condition of not hardening, at a room temperature for about several hours and raising the viscosity of resin, by performing sticking by pressure and an enlargement process, the sag by the self-weight of resin can be prevented and straight-line-like optical waveguide can be obtained mostly. A ferrule 20 is fixed to V Mizogami of a silicon substrate 4 using the adhesives 5 of a photoresist (drawing 9 (f)). If required, as shown in drawing 9 (g), transparent optical waveguide can be stiffened with light or heat using the transparence resin 7 of a refractive index lower than it, and it can fix. At this time, the transparence resin 7 of a low refractive index is not only used as a clad plate of an optical waveguide part, but carries out the duty of mechanical reinforcement.
[0023]
[Effect of the Invention] According to this invention, it is highly precise, moreover, junction between optical components can be performed to simplification, and the optical module of low cost is obtained.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is drawing showing the optical components junction approach by the example of this invention.

[Drawing 2] It is drawing showing how to form the transparence resin ball of a semicircle configuration in the carrier light-emitting part end face of the **** light emitting device by the example of this invention.

[Drawing 3] It is drawing showing how to form the transparence resin ball of a semicircle configuration in the carrier light-emitting part end face of the **** light emitting device by the example of this invention.

[Drawing 4] It is drawing showing how to form a bright film in the carrier light-emitting part end face of the **** light emitting device by the example of this invention.

[Drawing 5] It is drawing showing how to form the transparence resin ball of a semicircle configuration in the end face of the optical fiber by the example of this invention.

[Drawing 6] It is drawing showing how to form the transparence resin ball of a semicircle configuration in the end face of the optical fiber by the example of this invention.

[Drawing 7] It is drawing showing how to form the transparence resin ball of a semicircle configuration in the end face of the optical fiber by the example of this invention.

[Drawing 8] It is drawing showing the optical components junction approach by the example of this invention.

[Drawing 9] It is drawing showing the optical components junction approach by the example of this invention.

[Description of Notations]

1 — silica optical fiber and 2 — **** light emitting device, 3 — transparence resin, 4 — silicon substrate, 5, and 6 — adhesives, 7 — transparence resin, 8 — dam, and 9 — a **** light-emitting part, 10 — dispenser, 11 — photoresist, and 12 — a mask, 13 — bright film, 14 — transparence potting resin, and 15 -- liquefied transparence resin, 16 — optical waveguide section, the 17 — high refractive-index core section, and 18 — the low refractive-index clad section, 19 — plastics optical waveguide and 20 -- ferrule

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(54)【発明の名称】　光部品の接合方法

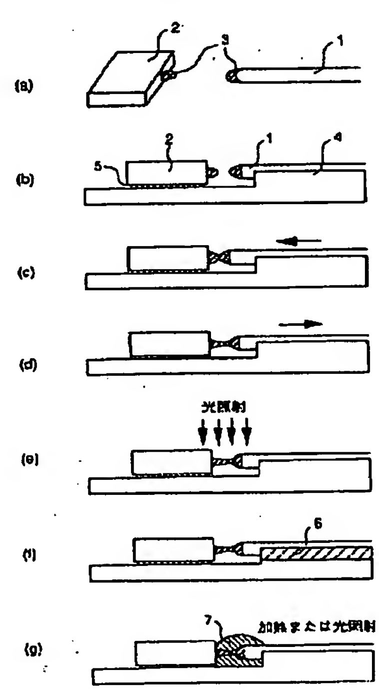
(57)【要約】

【課題】光部品間の光軸調整を高精度で簡略に行うことができる光部品接合方法の提供。

【解決手段】光ファイバの端面もしくは光受発光素子の開口部の少なくとも一方に未硬化状態の透明樹脂組成物を付着させる工程と、前記光ファイバと光受発光素子との光軸を概略一致するように配置する工程と、前記光ファイバと光受発光素子とを前記未硬化状態の透明樹脂組成物を介して圧着する工程と、前記光ファイバと光受発光素子とを引き戻し前記未硬化状態の透明樹脂組成物を延伸する工程と、該延伸された透明樹脂組成物を硬化させる工程とを含む光部品の接合方法。

【効果】光部品間の接合を高精度で、しかも簡略化して行うことができる。

図　1



【特許請求の範囲】

【請求項１】光ファイバの端面もしくは光受発光素子の開口部の少なくとも一方に未硬化状態の透明樹脂組成物を付着させる工程と、前記光ファイバと光受発光素子との光軸を概略一致するように配置する工程と、前記光ファイバと光受発光素子とを前記未硬化状態の透明樹脂組成物を介して圧着する工程と、前記光ファイバと光受発光素子とを引き戻し前記未硬化状態の透明樹脂組成物を延伸する工程と、該延伸された透明樹脂組成物を硬化させる工程とを含むことを特徴とする光部品の接合方法。

【請求項２】請求項１記載の光部品の接合方法において、前記透明樹脂組成物が光硬化性樹脂組成物であることを特徴とする光部品の接合方法。

【請求項３】請求項１記載の光部品の接合方法において、前記透明樹脂組成物が熱硬化性樹脂組成物であることを特徴とする光部品の接合方法。

【請求項４】請求項１記載の光部品の接合方法において、前記透明樹脂組成物が熱可塑性樹脂組成物であることを特徴とする光部品の接合方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、光送受信モジュールにおいて光部品間の接続を高精度で、しかも簡略にできる光部品接合方法に関する。

【０００２】

【従来の技術】光ファイバ通信は幹線系から加入者系へと適用が急速に拡大する動きにあり、そこに用いられる光送受信モジュールは小型，薄型，低コスト化が求められている。光モジュールでは、光ファイバのコア径が数μｍと非常に細いため、光ファイバと光受発光素子との光軸調整を高精度で行うことが非常に困難である。現状は主に、光部品に光を通しながら、手作業によって水平と垂直方向に微調整を行い、光接続の最大効率が得られる位置を捜している。そのため、製造コストが極めて高いものとなり、光部品間の光軸調整を簡略並びに低コストで行うことが必要となっている。

【０００３】光部品間の光軸調整を簡単に行う方法としては、特開平7−58149号公報に開示されている金ー錫はんだバンプによるリフローによって、金，錫はんだの表面張力を利用して光素子を所定の位置に実装する方法がある。また、特開昭60−173508号公報には光ファイバや光導波路などの光部品間に光硬化性の樹脂を介在させた後、光ファイバを通過した光で樹脂を硬化，屈折率を高めることにより、結合用導波路とし光部品間の接続を一括で行う方法が開示されている。

【０００４】

【発明が解決しようとする課題】前記従来技術は手作業による光軸調整と比べると簡略化されるものの、種々の点で問題がある。金ー錫はんだバンプ接続方法では、光軸合わせにおいて位置精度のバラツキを防ぐために、はんだバンプ径を約１μｍ以内の精度で均一にそろえる必要がある。また、光ファイバなどの光部品を、はんだバンプによる実装前に、あらかじめ高い精度で位置合わせし、固定しなければならない。そのための治具または基板の設置と位置合わせのための繁雑な作業を伴う。光硬化性の樹脂による方法では、光未照射部分が樹脂の未硬化部分となり液状または半固形状態で残るため、取扱性に劣る。また、光未照射部分は使用中に経時的に重合が進行するため、光導波路部分と他の部分との屈折率差が小さくなるなどの光学特性の変化がみられる。さらに、樹脂の硬化収縮は経時的な光軸ずれの問題をおこす。本発明の目的は光送受信モジュールにおいて光部品間の光軸調整を高精度で、しかも簡略化して行うとともに、使用中に経時的な光軸ずれの問題をおこさない信頼性に優れる光部品接合方法を提供することにある。

【０００５】

【課題を解決するための手段】本発明の光部品の接合方法は、光ファイバの端面もしくは光受発光素子の開口部の少なくとも一方に未硬化状態の透明樹脂組成物を付着させる工程と、前記光ファイバと光受発光素子との光軸を概略一致するように配置する工程と、前記光ファイバと光受発光素子とを前記未硬化状態の透明樹脂組成物を介して圧着する工程と、前記光ファイバと光受発光素子とを引き戻し前記未硬化状態の透明樹脂組成物を延伸する工程と、該延伸された透明樹脂組成物を硬化させる工程とを含むものである。

【０００６】本発明は、前記透明樹脂組成物が光硬化性樹脂組成物であり、光の照射によって該樹脂組成物を硬化させる光部品の接合方法である。

【０００７】本発明は、前記透明樹脂組成物が熱硬化性樹脂組成物であり、加熱によって該樹脂組成物を硬化させる光部品の接合方法である。

【０００８】本発明は、前記透明樹脂組成物が熱可塑性樹脂組成物であり、該熱可塑性樹脂組成物を加熱若しくは溶剤に溶解することにより未硬化状態とした光部品の接合方法である。

【０００９】本発明の光部品の接合方法において、光ファイバの端面もしくは光受発光素子の開口部の少なくとも一方に付着している未硬化状態の透明樹脂組成物はフィルム状でも液滴状でも良い。

【００１０】本発明の光部品接合方法において、光部品間の光軸調整を高精度で、しかも簡略化して行うことができるのは、光部品間に導光用の透明樹脂またはフィルムを光ファイバ径または光受発光素子の径に近い形状で形成することにより、光部品固定時の位置精度を１μｍ以内に設定する必要がないためである。光部品を数μｍ程度の精度で概略固定すれば、光部品間の光軸合わせを導光用の透明樹脂またはフィルムを用いて行うことができる。本発明における導光用の透明樹脂またはフィルムは光部品との接合後において完全重合体からなる均質な

組成で構成されるため、光学特性が均一であり、使用中の経時変化もなく安定である。

【0011】

【発明の実施の形態】本発明について図面を参照して説明する。

【0012】（実施例1）図1は本実施例による光部品接合方法を示す図である。石英光ファイバ1と光受発光素子2の各々の開口部端面に未硬化状態の液状で光硬化性の透明樹脂3を滴下して、半円形状の透明樹脂3の玉を形成する（図1（a））。未硬化の液状で光硬化性の透明樹脂3としては、テトラエチレングリコールジアクリレートとエチルアクリレートの組成物１００重量部に対して光重合開始剤としてベンジルジメチルケタール３重量部を加えた樹脂組成物を用いる。次に、光受発光素子２を接着剤５を用いて、シリコン基板４に搭載する。石英光ファイバ１はシリコン基板４に化学エッチングでＶ溝を設けた後、Ｖ溝上に搭載する（図１（ｂ））。この時、光受発光素子２と石英光ファイバ１はそれぞれ光受発光部と光ファイバ中心軸の軸ずれ量が数μｍ程度で概略一致するように配置する。また、受発光部と石英光ファイバ端との距離は最大限１０㎜程度とする。１０㎜を超えると、次の液状光硬化性の透明樹脂３の圧着，引き伸ばし工程時に樹脂が破断が起きて好ましくない。最小の距離としては、石英光ファイバ１と光受発光素子２の各々の端面に形成した前記樹脂玉がお互いに接触しない程度であればよい。この石英光ファイバ１を光受発光素子の方へ移動して前記透明樹脂を介して圧着した後、石英光ファイバの元に位置までもどし、透明樹脂３を引き伸ばす（図1（ｃ），（ｄ））。引き伸ばした未硬化状態の前記透明樹脂３は紫外線などの光照射により硬化して、光受発光部と石英光ファイバ１と間に透明な光導波路を形成する（図１（ｅ））。ここで、紫外線などの光照射は未硬化状態の前記透明樹脂３を引き伸ばしながら行うようにすれば、樹脂の自重によるたるみを防ぎほぼ直線状の光導波路が得られるため、特に好適である。石英光ファイバ１は光硬化性の接着剤６を用いてシリコン基板４のＶ溝上に固定する（図１（ｆ））。石英光ファイバのシリコン基板４のＶ溝上への固定は、図１（ｂ）の工程時にＶ溝上に光硬化性の接着剤６を塗付した後、石英光ファイバ１を搭載して、図１（ｅ）工程時の光照射により一括で行うこともできる。もし必要であれば、図１（ｇ）に示すように、透明な光導波路を該光導波路よりも低い屈折率の透明樹脂７を用いて、光または熱により硬化させ固定することができる。この時、低屈折率の透明樹脂７は光導波路部分のクラッド材としてだけでなく、機械的な補強材の役目もする。

【００１３】（実施例２）実施例１と同様にして石英光ファイバ１と光受発光素子２の各々の開口部端面に熱可塑性の透明樹脂３による半円形状の樹脂玉を形成する。熱可塑性樹脂としてポリメチルメタクリレートとブチル

アクリレートとの共重合体を用い、不揮発分８０ｗｔ％のテトラハイドロフラン溶液を石英光ファイバ１と光受発光素子２の各々の端面に滴下する。室温で４時間放置してほとんどの溶媒を揮散させた後、８０℃３０分加熱し、図１（ａ）に示す樹脂玉を形成する。石英光ファイバ１と光受発光素子２を図１（ｂ）に示すようにシリコン基板４に搭載した後、約１５０℃で赤外線加熱などの局所加熱を行いながら圧着し、次いで透明樹脂の引き伸ばしを行う（図１（ｃ），（ｄ））。図１（ｆ）に示すように、光硬化性の接着剤６を用いて石英光ファイバ１をシリコン基板４のＶ溝上に固定する。もし必要であれば、図１（ｇ）と同様に、形成した光導波路をそれよりも低い屈折率の透明樹脂７を用いて、光または熱により硬化させ固定することができる。本実施例では透明な光導波路として熱可塑性樹脂を用いているため、接着固定用としては光硬化性の樹脂を用いる方が好ましい。

【００１４】（実施例３）本実施例において、光受発光素子２の光受発光部９端面に半円形状の透明樹脂３の玉を形成する方法を図２に示す。図２（ａ）に示すように、光受発光部９の開口部端面にフォトレジスト材を塗付し、フォトマスクを通して紫外線をフォトレジスト材に照射した後、未露光部分のフォトレジスト材を溶剤でエッチング除去して液状の透明樹脂３の玉を形成するためのダム８を形成する。次にディスペンサ１０を用いて液状の熱または光硬化性樹脂を光受発光部９端面のダム８内に滴下して半円形状の透明樹脂３の玉を形成する（図２（ｂ））。この時、液状の熱または光硬化性樹脂の代わりに溶剤に溶解させた熱可塑性樹脂を用いることもできる。

【００１５】（実施例４）図３は本実施例において、光受発光素子の受発光部端面に半円形状の透明樹脂玉を形成する方法を示す図である。図３（ａ）に示すように、光受発光素子２の光受発光部９の端面をフッ酸（ＨＦ）で凹状にエッチングする。この時、エッチング用マスクとしてソルダレジストを用いる。その後、この光受発光部９の端面の凹部にディスペンサを用いて液状の熱または光硬化性樹脂を滴下して半円形状の透明樹脂３の玉を形成する。なお実施例３と同様に溶剤に溶解させた熱可塑性樹脂を滴下しても良い。

【００１６】（実施例５）本実施例において、光受発光素子２の光受発光部９の端面に透明フィルムを形成する方法を図４に示す。図４（ａ）に示すように、透明なポジ型のフォトレジストフィルム１１を光受発光素子２の端面にラミネートした後、光受発光部９の開口部以外をクロムめっきしたガラス製フォトマスクを通して紫外線をフォトレジストフィルム１１に照射する。次にレジストフィルムの未露光部分を溶剤によりエッチング除去し、光受発光素子２の光受発光部９の端面の開口部に透明フィルムを形成する（図４（ｂ））。本実施例の、ポジ型フォトレジストの代わりにネガ型フォトレジストを

用いて光受発光素子２の光受発光部９の端面に透明フィルムを形成することも可能である。

【００１７】（実施例６）本実施例の、石英光ファイバ１の端面に半円形状の透明樹脂玉を形成する方法を図５に示す。図５の（ａ）に示すように、石英光ファイバ１の端面にディスペンサ１０を用いて液状の熱または光硬化性の透明ポッテイング樹脂１４を滴下する。滴下した液状の透明樹脂は表面張力によって半円形状の透明樹脂３の玉が形成する。（図５（ｂ））。本実施例では、液状の熱または光硬化性樹脂の代わりに溶剤に溶解させた熱可塑性樹脂も用いることができる。

【００１８】（実施例７）本実施例の、石英光ファイバ１の端面に半円形状の透明樹脂３の玉を形成する方法を図６に示す。図６（ａ）に示すように、石英光ファイバ１の端面を熱または光で硬化する液状の透明樹脂１５に接触させる。この時、石英光ファイバ１の端面は液状の透明樹脂１５に中に入れないようにする。次に前記光ファイバを引き上げることにより、石英光ファイバ１の端面に半円形状の液状の透明樹脂３の玉を形成する（図６（ｂ））。ここでは実施例６と同様に溶剤に溶解させた熱可塑性樹脂を用いることができる。

【００１９】（実施例８）本実施例の、光ファイバの端面に半円形状の透明樹脂３の玉を形成する方法を図７に示す。図７（ａ）に示すように、石英光ファイバ１の光導波路部１６の端面をフッ酸（ＨＦ）を用いて凹状にエッチングする。光ファイバ端面を水洗，加熱乾燥させた後、該光ファイバ端面の凹部にディスペンサを用いて液状の熱または光硬化性樹脂を滴下して半円形状の透明樹脂３の玉を形成する（図７（ｂ））。ここでは実施例６と同様に溶剤に溶解させた熱可塑性樹脂を用いることができる。

【００２０】（実施例９）本実施例による光部品接合方法を図８に示す。石英光ファイバ１の端面に長さ１㎜のプラスチック光導波路を接着する（図８（ａ））。プラスチック光導波路は高屈折率コア部１７がポリメチルメタクリレートとからなり、低屈折率クラッド部１８がフッ素化ポリメチルメタクリレートからなる光ファイバを外径１０～２０μｍになるまで熱延伸して作製する。前記プラスチック光導波路と石英光ファイバ１とを、光硬化性のシリコーン樹脂，アクリル樹脂、またはポリウレタン樹脂接着剤を各々の端面のどちらかまたは両方に塗付した後、各々の端面を突き合わせたまま紫外線照射することによって接着する。この時、プラスチック光導波路を溶解する溶剤、例えば塩化メチレンなどを、プラスチック光導波路と石英光ファイバとの突き合わせ部分に注入した後、乾燥することにより両者の接着を行うこともできる。

【００２１】次に、光受発光素子２の開口部端面に未硬化状態の液状光硬化性透明樹脂を滴下して、半円形状の透明樹脂３の玉を形成する（図８（ｂ））。未硬化の液状光硬化性透明樹脂としては、イソシアネートとポリエーテルグリコールからなるウレタン樹脂とヒドロキシルエチルアクリレートとを反応させたウレタンアクリレート樹脂組成物１００重量部に、光重合開始剤として２－ヒドロキシ－２－メチル－１－フェニル－プロパン－１－オン３重量部を加えた樹脂組成物を用いる。その後、光受発光素子２を接着剤５を用いて、シリコン基板４に搭載する。石英光ファイバ１は予めシリコン基板４に化学エッチングでＶ溝を設けた後、Ｖ溝上に搭載する（図８（ｃ））。この時、光受発光素子２と石英光ファイバ１はそれぞれ光受発光部と光ファイバ中心軸の軸ずれ量が数μｍ程度で概略一致するように配置する。また、光受発光部と石英光ファイバとの距離は０．５㎜ 程度とする。この石英光ファイバを受発光素子の方へ移動して透明樹脂３を介して圧着した後、石英光ファイバを元の位置までもどし透明樹脂３を引き伸ばす（図８（ｄ），（ｅ））。引き伸ばした未硬化状態の液状光硬化性透明樹脂を紫外線などの光の照射により硬化させ、光受発光部と石英光ファイバに接続したプラスチック光導波路とを接着させる。（図８（ｆ））。石英光ファイバは光硬化性の接着剤を用いてシリコン基板のＶ溝上に固定する（図８（ｇ））。石英光ファイバのシリコン基板Ｖ溝上への固定は、図８（ｃ）の工程時にＶ溝上に光硬化性の接着剤６を塗付した後、石英光ファイバを搭載して、図８（ｆ）の工程時の光照射により一括で行うこともできる。もし必要であれば、図８（ｈ）に示すように、前記透明樹脂３より低屈折率の透明樹脂７を用いて、光または熱により硬化させ固定することができる。この時、低屈折率の透明樹脂７は光導波路部分のクラッド材としてて使われるだけでなく、機械的な補強の役目もする。

【００２２】（実施例１０）本実施例による光部品の接合方法を図１０に示す。本実施例は石英光ファイバ１を金属またはガラス製のフェルール２０に挿入した後、フェルールをシリコン基板４のＶ溝上に搭載し、光ファイバと光受発光素子の接合を行う方法である。長さ３０㎜に切断した石英光ファイバ１をジルコニア製フェルール２０に挿入して光硬化性の接着剤を用いて固定した後、この光ファイバと光受発光素子２の各々の開口部端面に未硬化状態の液状熱硬化性の透明樹脂３を滴下して、半円形状の樹脂玉を形成する（図９（ａ））。未硬化の液状熱硬化性透明樹脂としては、室温で硬化できる２液性の透明シリコン樹脂を用いる。次に、光受発光素子２を接着剤５を用いて、シリコン基板４に搭載する。石英光ファイバ１はシリコン基板４に化学エッチングでＶ溝を設けた後、Ｖ溝上に搭載する（図９（ｂ））。この時、光受発光素子２と石英光ファイバ１はそれぞれ光受発光部と光ファイバ中心軸の軸ずれ量が数μｍ程度で概略一致するように配置する。また、光受発光部と石英光ファイバとの距離は２㎜程度とする。この石英光ファイバ１を挿入したフェルール２０を受発光素子の方へ移動して

透明樹脂３を介して圧着した後、フェルールを元に位置までもどして透明樹脂３を引き伸ばす（図１（ｃ），（ｄ））。引き伸ばした未硬化状態の液状熱硬化性透明樹脂は室温で２０時間放置した後に６０℃１時間の条件で熱硬化して、光受発光部と石英光ファイバ１との間に光導波路を形成する（図９（ｅ））。ここで、未硬化状態の前記シリコーン透明樹脂を室温で数時間程度放置して樹脂の粘度を上げた後、圧着，引き伸ばし工程を行うことにより、樹脂の自重によるたるみを防ぎ、ほぼ直線状の光導波路を得ることができる。フェルール２０は光硬化性の接着剤５を用いてシリコン基板４のＶ溝上に固定する（図９（ｆ））。必要であれば、図９（ｇ）に示すように、透明な光導波路をそれよりも低い屈折率の透明樹脂７を用いて、光または熱により硬化させ固定することができる。この時、低屈折率の透明樹脂７は光導波路部分のクラッド材として使われるだけでなく、機械的な補強の役目もする。

【００２３】

【発明の効果】本発明によれば、光部品間の接合を高精度で、しかも簡略化に行うことができ、低コストの光モジュールが得られる。

【図面の簡単な説明】

【図１】本発明の実施例による光部品接合方法を示す図である。

【図２】本発明の実施例による光受発光素子の受発光部端面に半円形状の透明樹脂玉を形成する方法を示す図である。

【図３】本発明の実施例による光受発光素子の受発光部端面に半円形状の透明樹脂玉を形成する方法を示す図である。

【図４】本発明の実施例による光受発光素子の受発光部端面に透明フィルムを形成する方法を示す図である。

【図５】本発明の実施例による光ファイバの端面に半円形状の透明樹脂玉を形成する方法を示す図である。

【図６】本発明の実施例による光ファイバの端面に半円形状の透明樹脂玉を形成する方法を示す図である。

【図７】本発明の実施例による光ファイバの端面に半円形状の透明樹脂玉を形成する方法を示す図である。

【図８】本発明の実施例による光部品接合方法を示す図である。

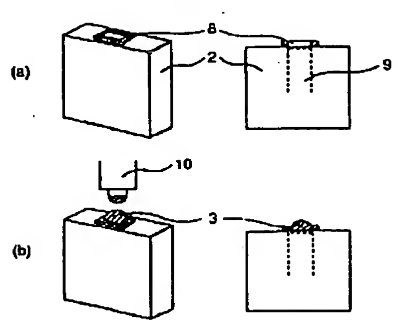
【図９】本発明の実施例による光部品接合方法を示す図である。

【符号の説明】

１…石英光ファイバ、２…光受発光素子、３…透明樹脂、４…シリコン基板、５，６…接着剤、７…透明樹脂、８…ダム、９…光受発光部、１０…ディスペンサ、１１…フォトレジスト、１２…マスク、１３…透明フィルム、１４…透明ポッティング樹脂、１５…液状の透明樹脂、１６…光導波路部、１７…高屈折率コア部、１８…低屈折率クラッド部、１９…プラスチック光導波路、２０…フェルール。

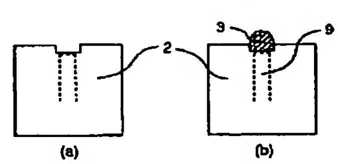
【図２】

図　2



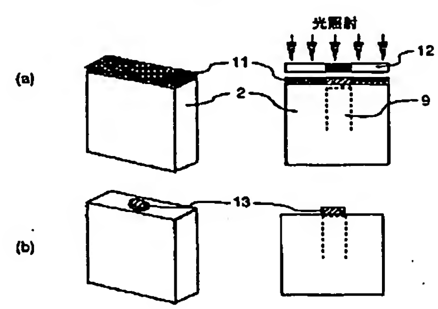
【図３】

図　3



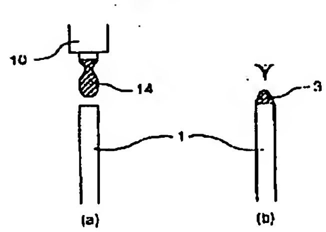
【図４】

図　4



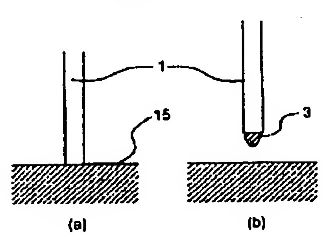
【図５】

図　5



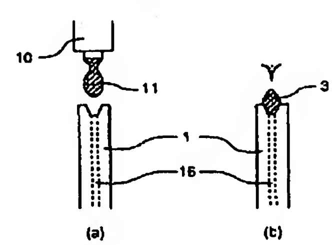
【図６】

図　6



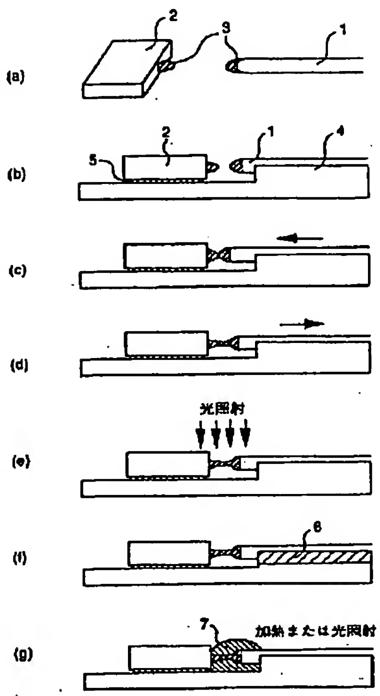
【図７】

図　7



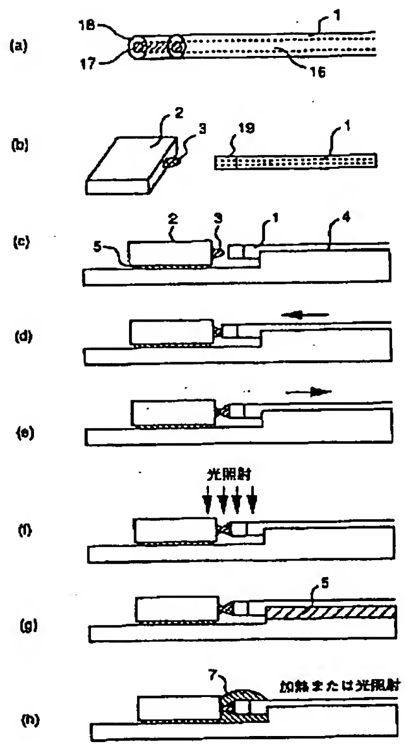
【図1】

図 1



【図8】

図 8



【図9】

図 9